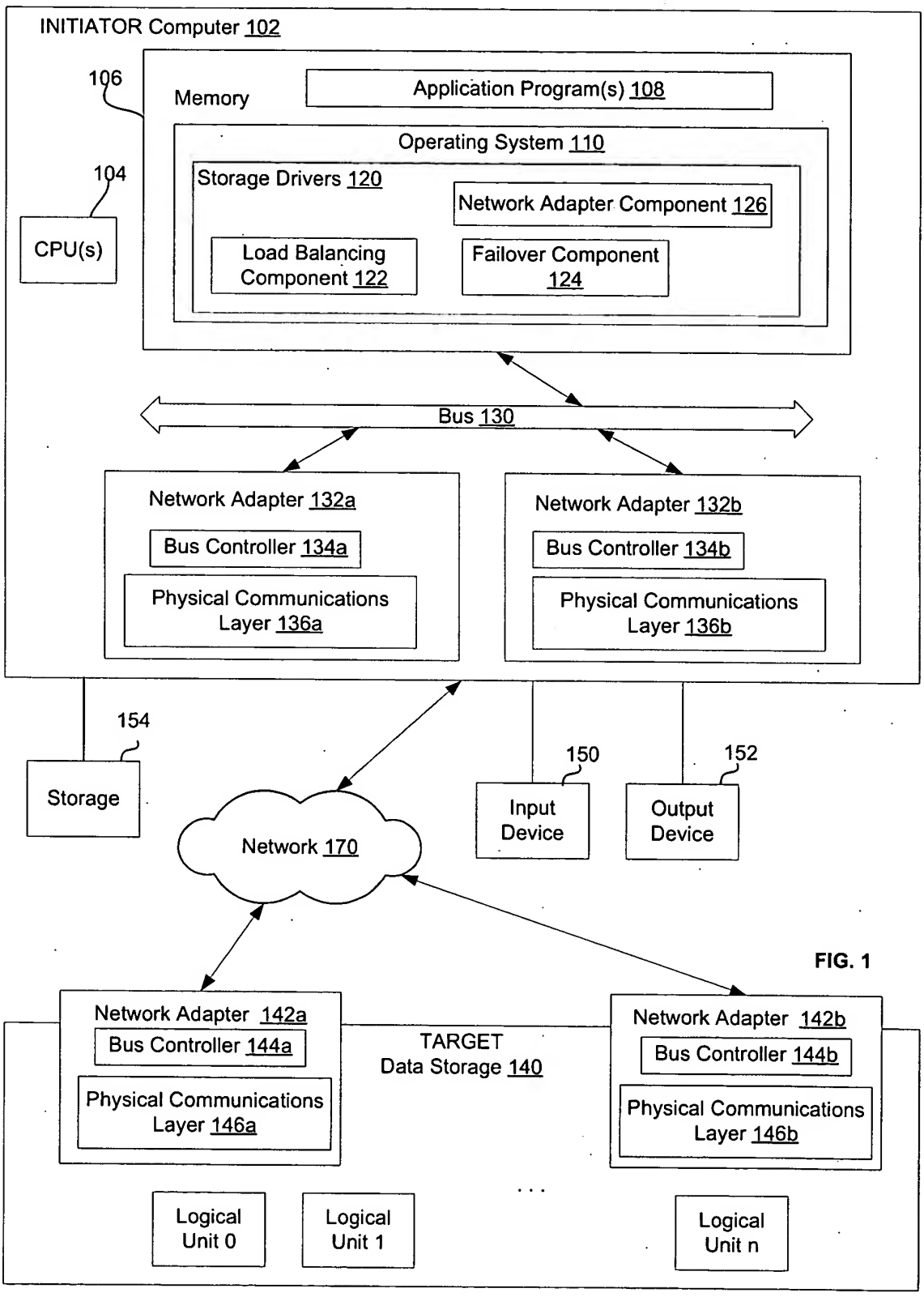
INITIATOR Computer 102
106
Memory
Application Program(s) 108
Operating System 110
104
Storage Drivers 120
Network Adapter Component 126
CPU(s)
Load Balancing Component 122
Failover Component 124
Bus 130
Network Adapter 132a
Bus Controller 134a
Physical Communications Layer 136a
Network Adapter 132b
Bus Controller 134b
Physical Communications Layer 136b
154
150
152
Storage
Network 170
Input Device
Output Device
Network Adapter 142a
Bus Controller 144a
Physical Communications Layer 146a
TARGET Data Storage 140
Network Adapter 142b
Bus Controller 144b
Physical Communications Layer 146b
Logical Unit 0
Logical Unit 1
Logical Unit n

FIG. 1

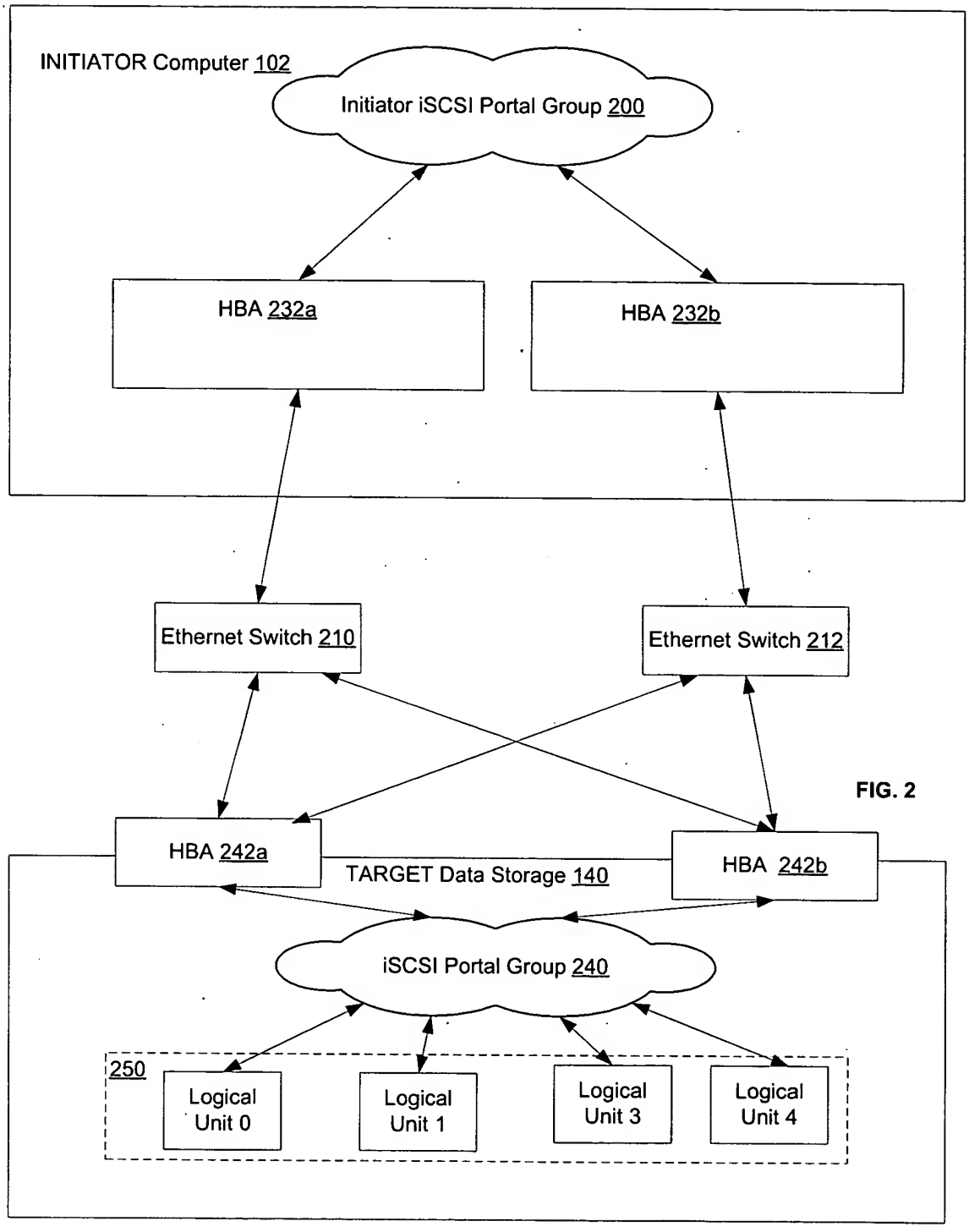
INITIATOR Computer 102
Initiator iSCSI Portal Group 200
HBA 232a
HBA 232b
Ethernet Switch 210
Ethernet Switch 212
HBA 242a
TARGET Data Storage 140
HBA 242b
iSCSI Portal Group 240
250
Logical Unit 0
Logical Unit 1
Logical Unit 3
Logical Unit 4

FIG. 2

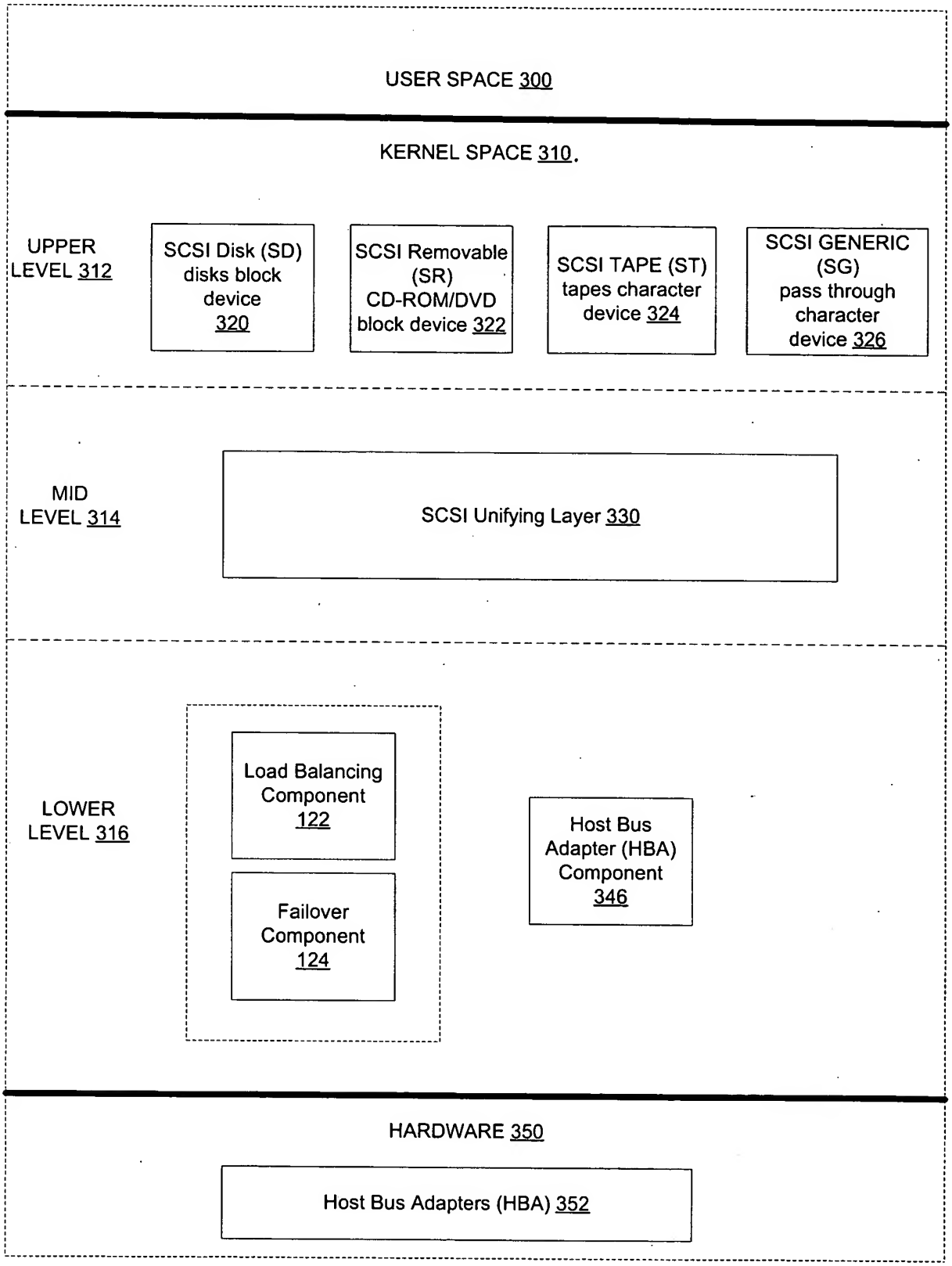
USER SPACE 300
KERNEL SPACE 310.
UPPER LEVEL 312
SCSI Disk (SD) disks block device 320
SCSI Removable (SR) CD-ROM/DVD block device 322
SCSI TAPE (ST) tapes character device 324
SCSI GENERIC (SG) pass through character device 326
MID LEVEL 314
SCSI Unifying Layer 330
LOWER LEVEL 316
Load Balancing Component 122
Failover Component 124
Host Bus Adapter (HBA) Component 346
HARDWARE 350
Host Bus Adapters (HBA) 352

FIG. 3

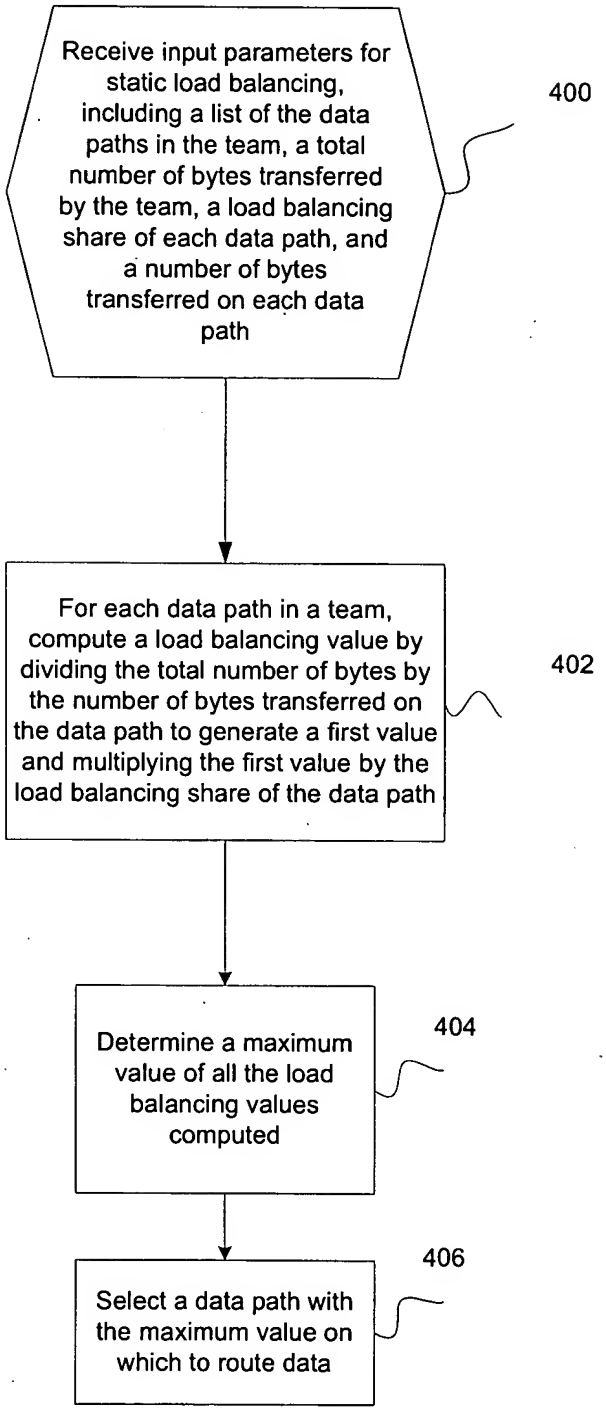
Receive input parameters for static load balancing, including a list of the data paths in the team, a total number of bytes transferred by the team, a load balancing share of each data path, and a number of bytes transferred on each data path
400
For each data path in a team, compute a load balancing value by dividing the total number of bytes by the number of bytes transferred on the data path to generate a first value and multiplying the first value by the load balancing share of the data path
402
Determine a maximum value of all the load balancing values computed
404
Select a data path with the maximum value on which to route data
406

FIG. 4

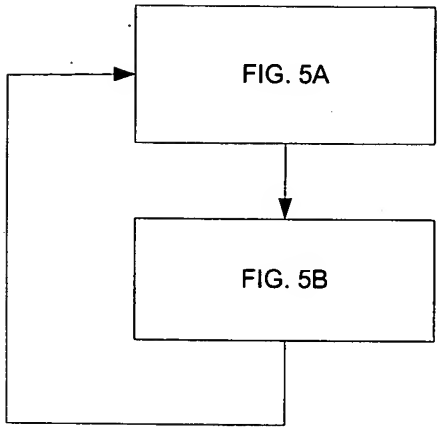

FIG. 5

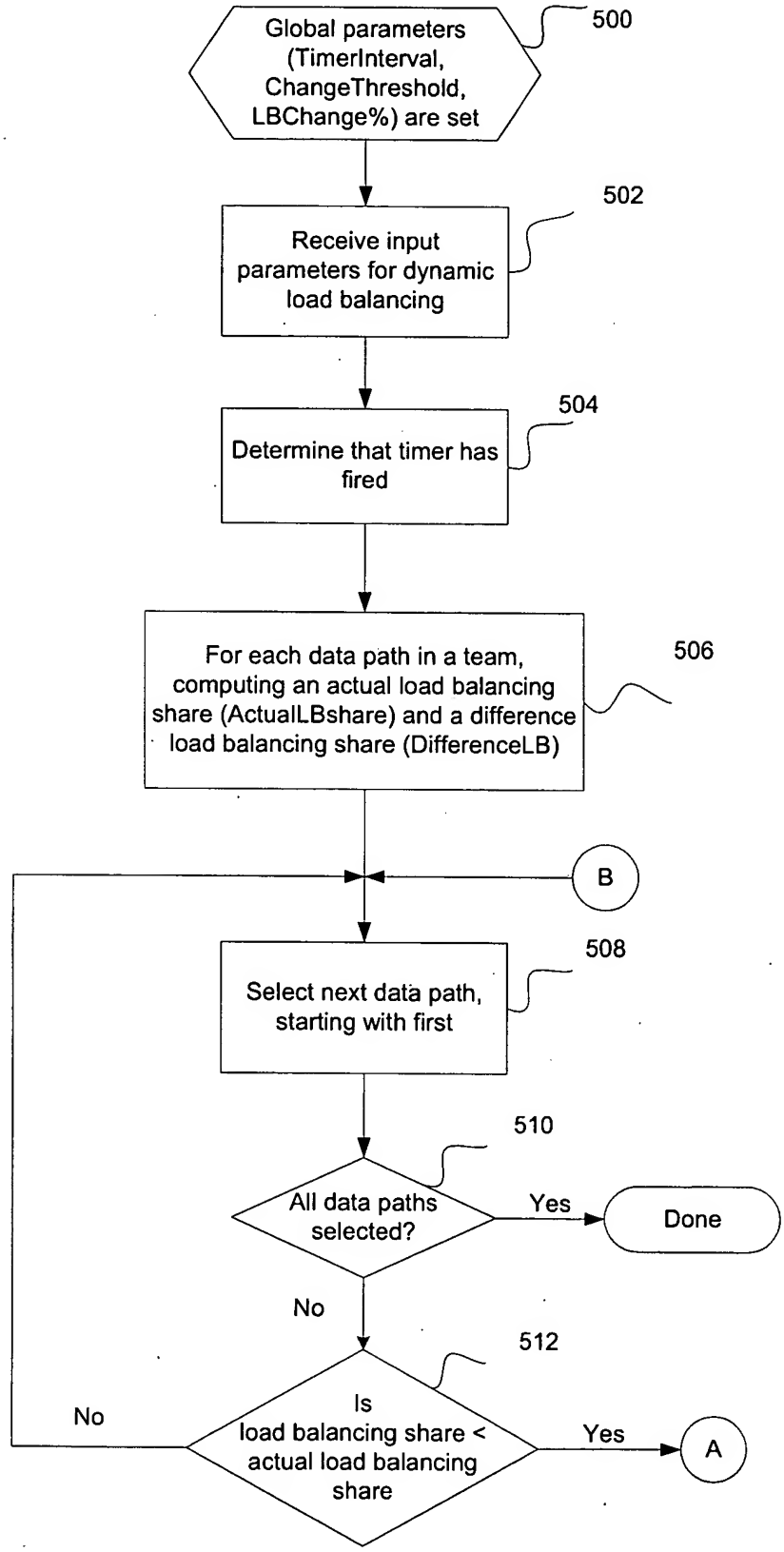
Global parameters (TimerInterval, ChangeThreshold, LBChange%) are set
500
Receive input parameters for dynamic load balancing
502
Determine that timer has fired
504
For each data path in a team, computing an actual load balancing share (ActualLBshare) and a difference load balancing share (DifferenceLB)
506
B
Select next data path, starting with first
508
All data paths selected?
510
Yes
Done
No
Is load balancing share < actual load balancing share
512
No
Yes
A

FIG. 5A

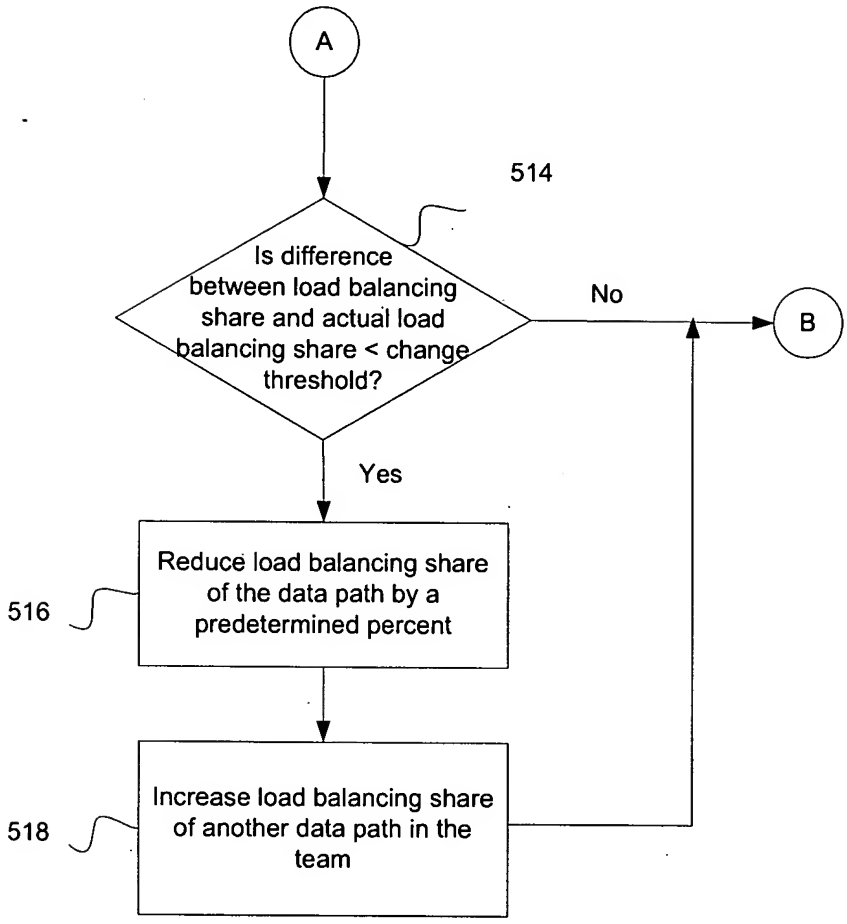
A
514
Is difference between load balancing share and actual load balancing share < change threshold?
No
B
Yes
Reduce load balancing share of the data path by a predetermined percent
516
Increase load balancing share of another data path in the team
518

FIG. 5B

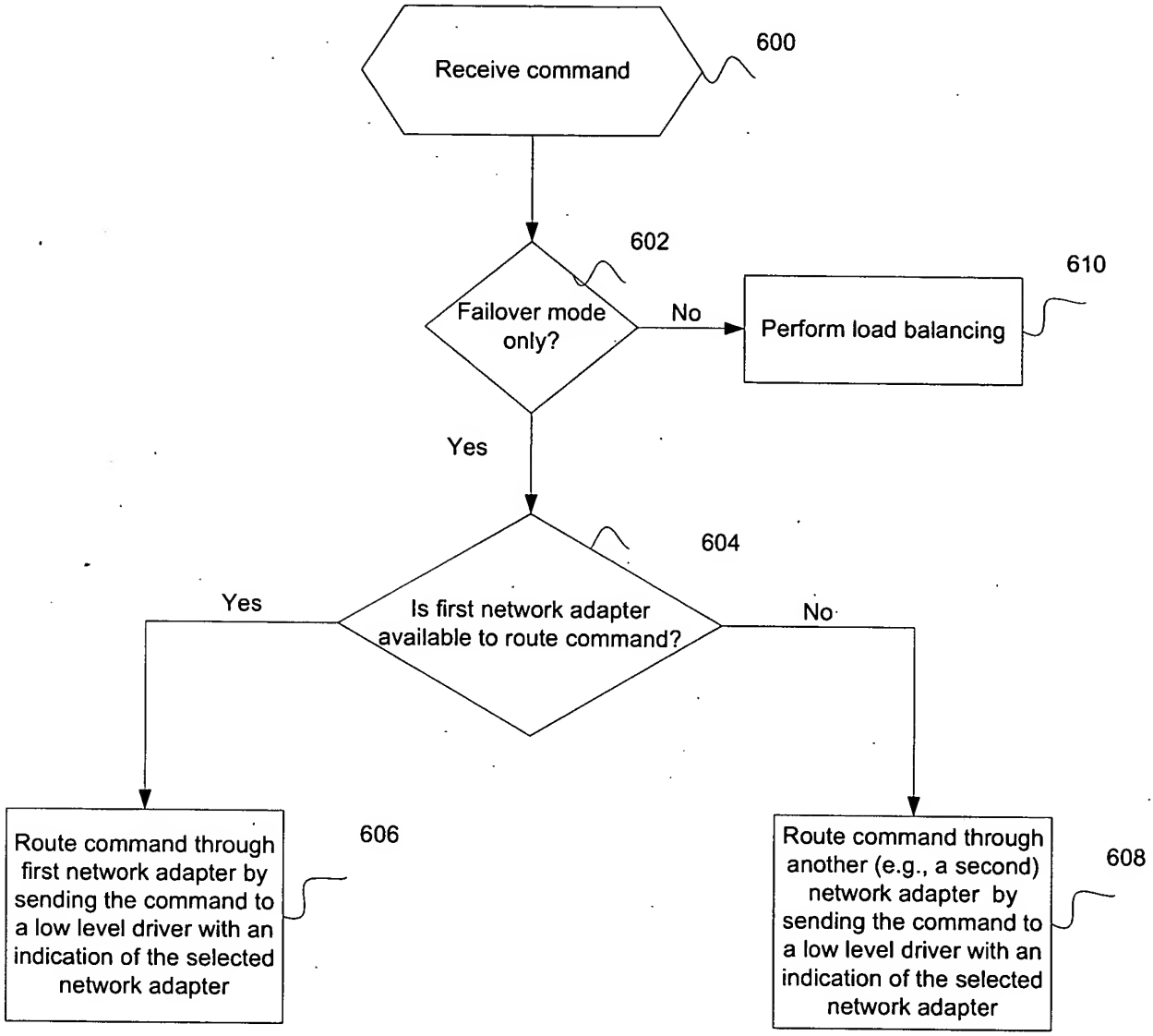
Receive command
600
602
Failover mode only?
No
Perform load balancing
610
Yes
604
Is first network adapter available to route command?
Yes
No
Route command through first network adapter by sending the command to a low level driver with an indication of the selected network adapter
606
Route command through another (e.g., a second) network adapter by sending the command to a low level driver with an indication of the selected network adapter
608

FIG. 6

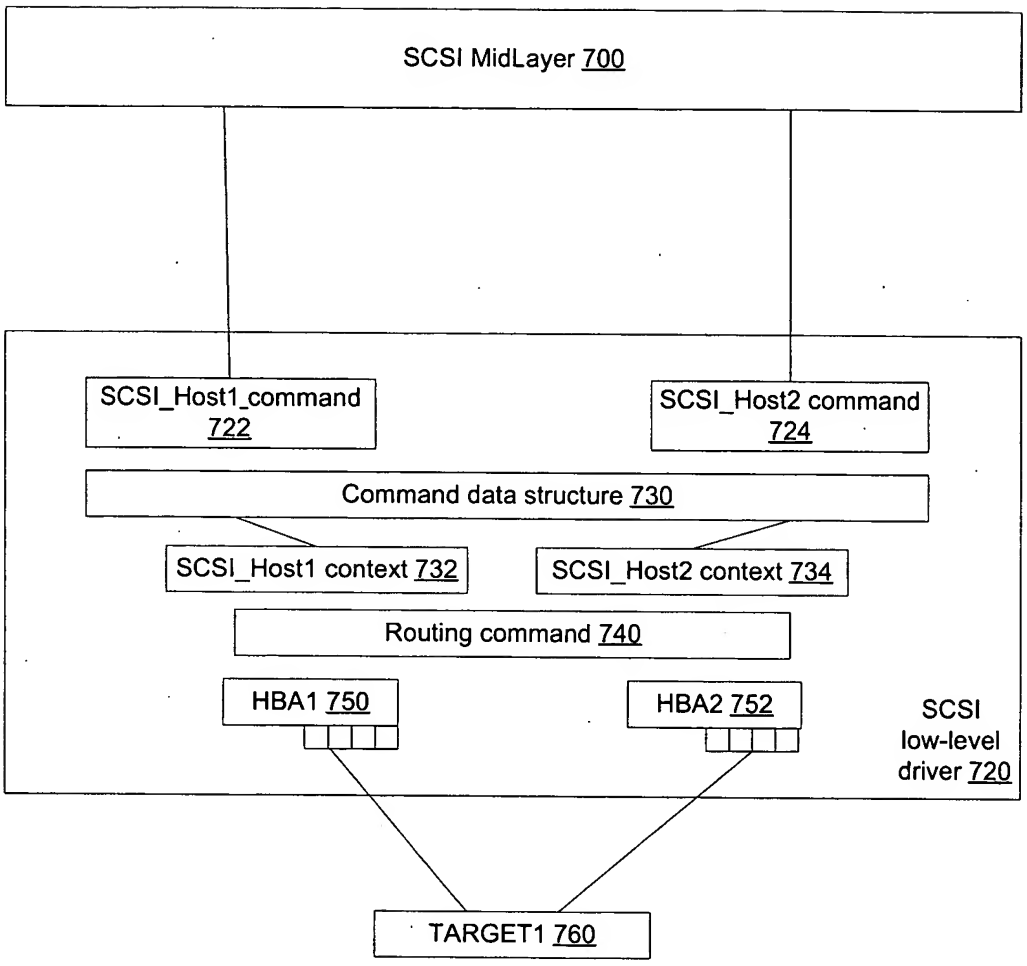
SCSI MidLayer 700
SCSI_Host1_command 722
SCSI_Host2 command 724
Command data structure 730
SCSI_Host1 context 732
SCSI_Host2 context 734
Routing command 740
HBA1 750
HBA2 752
SCSI low-level driver 720
TARGET1 760

FIG. 7

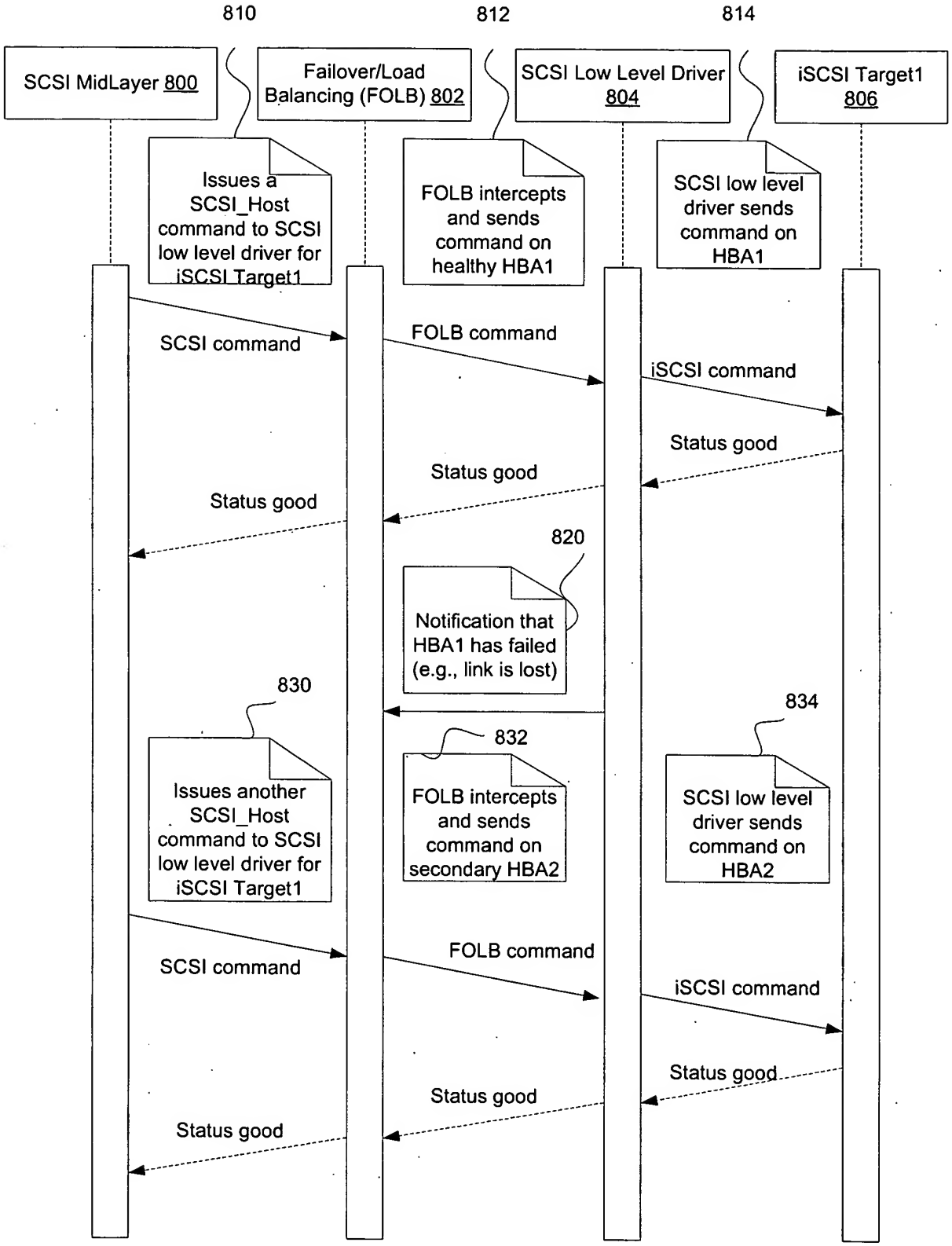
810
812
814
SCSI MidLayer 800
Failover/Load Balancing (FOLB) 802
SCSI Low Level Driver 804
iSCSI Target1 806
Issues a SCSI_Host command to SCSI low level driver for iSCSI Target1
FOLB intercepts and sends command on healthy HBA1
SCSI low level driver sends command on HBA1
SCSI command
FOLB command
iSCSI command
Status good
Status good
Status good
820
Notification that HBA1 has failed (e.g., link is lost)
830
832
834
Issues another SCSI_Host command to SCSI low level driver for iSCSI Target1
FOLB intercepts and sends command on secondary HBA2
SCSI low level driver sends command on HBA2
SCSI command
FOLB command
iSCSI command
Status good
Status good
Status good

FIG. 8